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Minnesota Department of Natural Resources
Division of Minerals
Minerals Exploration Section

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GEOPHYSICAL AND GEOCHEMICAL SURVEYS, SKELETON LAKE AREA, ST. LOUIS COUNTY, MINNESOTA

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INTRODUCTION

In 1974-75, diamond drilling in an area near Skeleton Lake in St. Louis County intersected massive sulfide containing over 3% copper (Figure 1). The massive sulfide occurs in intermediate to mafic metavolcanics. Agglomerate is common in the area.

The Minerals Division of the Minnesota Department of Natural Resources, having the responsibility of assessing the mineral potential of state controlled lands, felt this area required further evaluation. The state controlled land in this area is extensive. Therefore, geophysical and geochemical surveys were conducted in 1975 and 1976 for the objectives of identifying geophysical conductors and geochemical trends which may reflect economic mineralization. The purpose of these surveys was to produce a reconnaissance type assessment of the mineral potential of the area.

The geophysical and geochemical surveys described in this report are generally reconnaissance in scope. The geophysical surveys (EM and magnetics) were conducted on portions of the grid established for the above described drilling, and extended outward from this grid. The geochemical surveys consisted of lake sediment, organic stream bank, surface soil and peat sampling.

The geophysical data for this report was derived by Minerals Division field surveys and from open file lease information supplied by exploration companies.

PROCEDURES

The Minerals Division ran VLF-EM (Geonics EM-16) and horizontal shootback EM (Crone CEM) on portions of the existing grid at Skeleton Lake. The Minerals Division also did regional reconnaissance with several long, approximately north-south, lines run with VLF-EM, CEM and magnetics. Open file lease data from the region includes vertical field magnetics, IP, horizontal loop EM, and vertical loop EM on the grid, and airborne EM and magnetics for an area several miles to the west of Skeleton Lake.

The lake sediment geochemical samples from this area were collected as part of a regional survey conducted by the Minerals Division, and sampling procedures are described in a report covering that survey (Meineke, Vadis and Klaysmat, 1976). The organic stream bank samples were collected at approximately 500 foot intervals along the inflow and outflow streams of Skeleton Lake. A-horizon and B-horizon soil samples and peat were collected on lines 4W and 00 of the existing grid.

GEOPHYSICAL RESULTS

Profiles of the data for the horizontal shootback electromagnetics are plotted on Map A-1. The drill holes which intersected copper mineralization are shown on Map A-1 and other maps. The VLF-EM data is plotted on Maps B-1 and B-2, and the magnetic profiles are plotted on Maps C-1 and C-2. A generalized graphical representation of the electromagnetic conductors and associated magnetic anomalies of the Skeleton Lake region are shown on Map D. Map D represents data taken from airborne geophysics in the western portion of the region and ground geophysics in the eastern portion of the region. The approximately north-south airborne and ground lines intersect a series of conductors and magnetic anomalies. The profiles for the ground geophysics are plotted on Maps A-1, B-1 and C-1. It may be inferred from these patterns of conductor intersections that a regional strike of approximately N60°W to N90°W exists. The axis of some of the conductors were traced for several thousand feet, and they roughly maintain this direction. It is expected that general continuity of this direction should be encountered; however, local variations may exist. This direction generally agrees with the bulk of the geologic strike encountered from a limited number of measurements. The general apparent dip of the region, as inferred from magnetic data from Maps C-1 and C-2, is to the north and varies from approximately 45° to 90°. An occasional southerly dip is indicated from the magnetic data. This trend is generally compatible with the limited number of geologic dips measured in the region.

The general trend of the EM anomaly pattern appears to abruptly stop at the easternmost reconnaissance line (Map A-1) which runs approximately through the center of section 9.

VLF-EM, CEM and magnetics were conducted over six lakes in the area. All lakes responded to VLF-EM. The only lake which produced a significant CEM anomaly was Skeleton Lake. Some secondary anomalies were encountered in other lakes with CEM.

GEOCHEMICAL RESULTS

Geochemical sampling was conducted in the area of Skeleton Lake. Samples were taken of organic-rich lake sediments, organic stream bank samples, soils and peat.

The organic-rich lake sediments from the area were taken as part of a regional lake sediment survey conducted by the Division of Minerals (Meineke,

Vadis and Klaysmat, 1976). The results of the survey from the Skeleton Lake area are shown on Figure 2. Skeleton Lake produced a copper anomaly which falls within the upper 2% of all samples from the entire Lake Vermilion-Ely region. The conductor which contains the copper is approximately l,000 feet down drainage, 70 feet lower in elevation and is down glacial ice direction from Skeleton Lake. It is, therefore, unlikely that the drilled portion of this conductor produced the geochemical copper anomaly in Skeleton Lake.

The results of the organic stream bank survey are presented in Table 1. The sample locations are shown on Figure 3. This survey was conducted on streams adjacent to Skeleton Lake and indicate a copper source in the area of Skeleton Lake. The survey also indicates the source of the copper anomaly lies north of the conductor which was drilled. The organic stream bank sample media has been shown to reflect copper-nickel mineralization in an area with glacial history similar to that of Skeleton Lake (Meineke, Vadis and Klaysmat, 1977).

An A-horizon, B-horizon and peat sampling survey was conducted in a very limited area in the proximity of the baseline and line 4W of the existing grid. The results of this survey show little indication of mineralization and are not presented here. This soil and peat survey was very limited in area and was meant to serve as a pilot study for possible regional soil surveys which would be required to evaluate the relation of soil geochemistry to possible mineralization in the area.

CONCLUSIONS

The general geophysical pattern of the area indicates several conductive horizons which are more or less continuous in a N60°W to N90°W trend and are dipping to the north at approximately 45° to 90°. Due to the high magnetics associated with portions of these conductors, the conductors may, in part, be the result of iron formation.

The conductors which exist over and north of Skeleton Lake (Map A-1) and extend east and west from the lake are of particular interest due to the geochemical data available from this area. Skeleton Lake produced a significant copper anomaly from the lake sediment geochemical survey. The organic stream bank sampies also indicate a copper source near Skeleton Lake. These geochemical anomalies indicate a source remote from the drilled conductor. The conductors near Skeleton Lake appear to be associated with a large magnetic anomaly and may be associated, in part, with magnetic iron formation. However, the drill holes which intersected copper mineralization in the area also intersected iron formation. The geochemical and geophysical evidence indicates that conductors exist in the area of Skeleton Lake which may be related to economic mineralization.

Several more regional conductors have been identified in the area surrounding Skeleton Lake (Map D). These conductors have the potential to be related to economic mineralization.

TABLE 1: Element concentrations for organic stream bank samples

Sample Number	Ag (ppm)	As (ppm)	Co (ppm)	Cu (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)	Fe (%)	Mn (ppm)
2870	0	2	4	6	8	3	36	1.39	900
2871	0	2	3	12	14	5	37	1.42	2,000
2872	0	17	4	10	8	4	45	3.05	1,500
2873	0	2	7	7	10	5	27	1.59	2,900
2874	0	2	8	14	8	9	64	2.82	3,200
2875	0	5	3	96	20	5	43	2.66	20,450
2876	0	4	11	97	23	10	50	1.99	7,400
2877	0	0	8	83	23	4	39	.81	1,100
2879	0	2	5	58	21	2	50	.83	1,250
2880	0	0	9	52	22	5	53	.84	1,600
2881	0	0	7	62	23	6	80	1.71	3,850
6632	0	4	8	76	27	0	27	.41	980
6633	0	2	10	40	13	0	50	.41	1,320

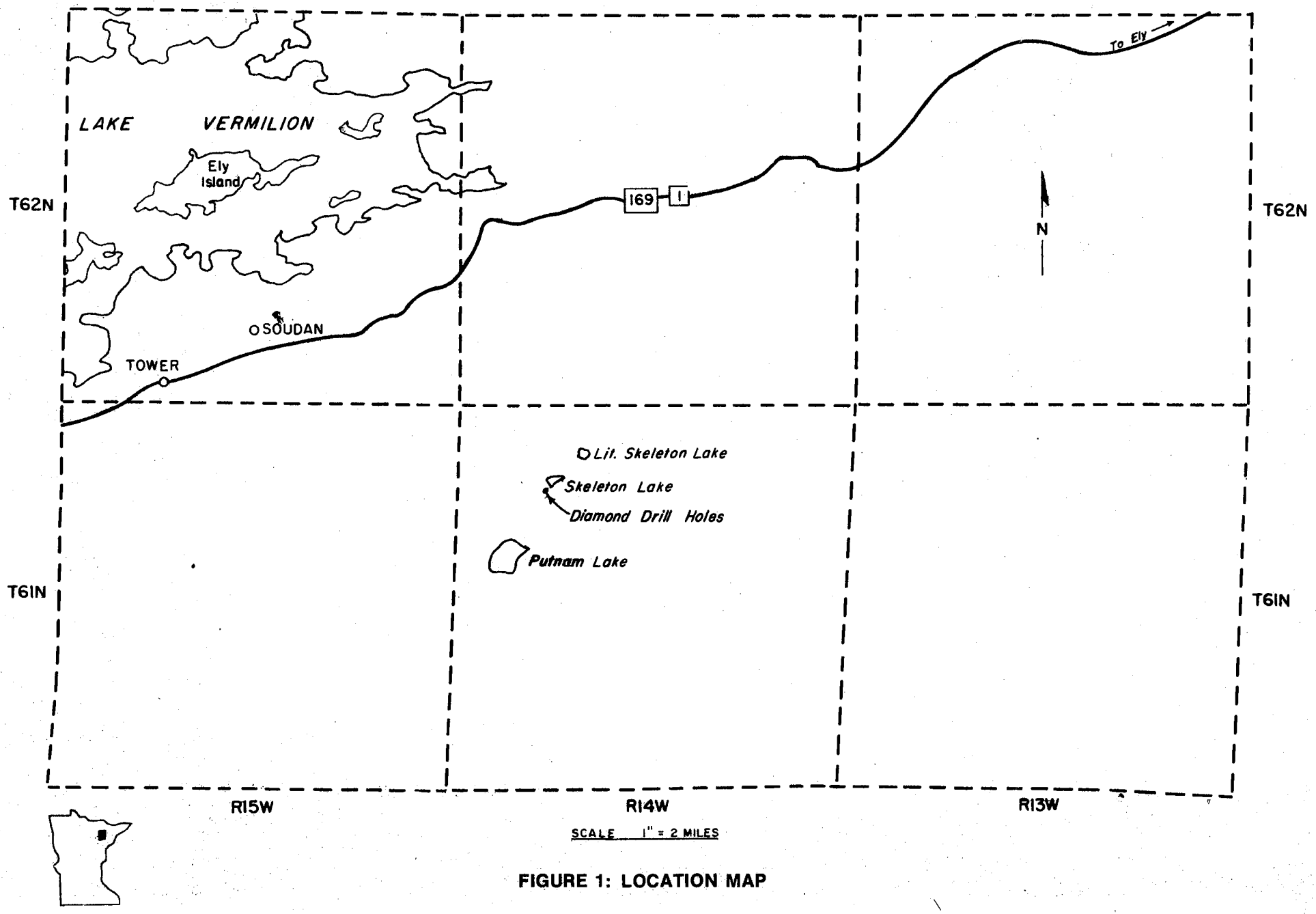
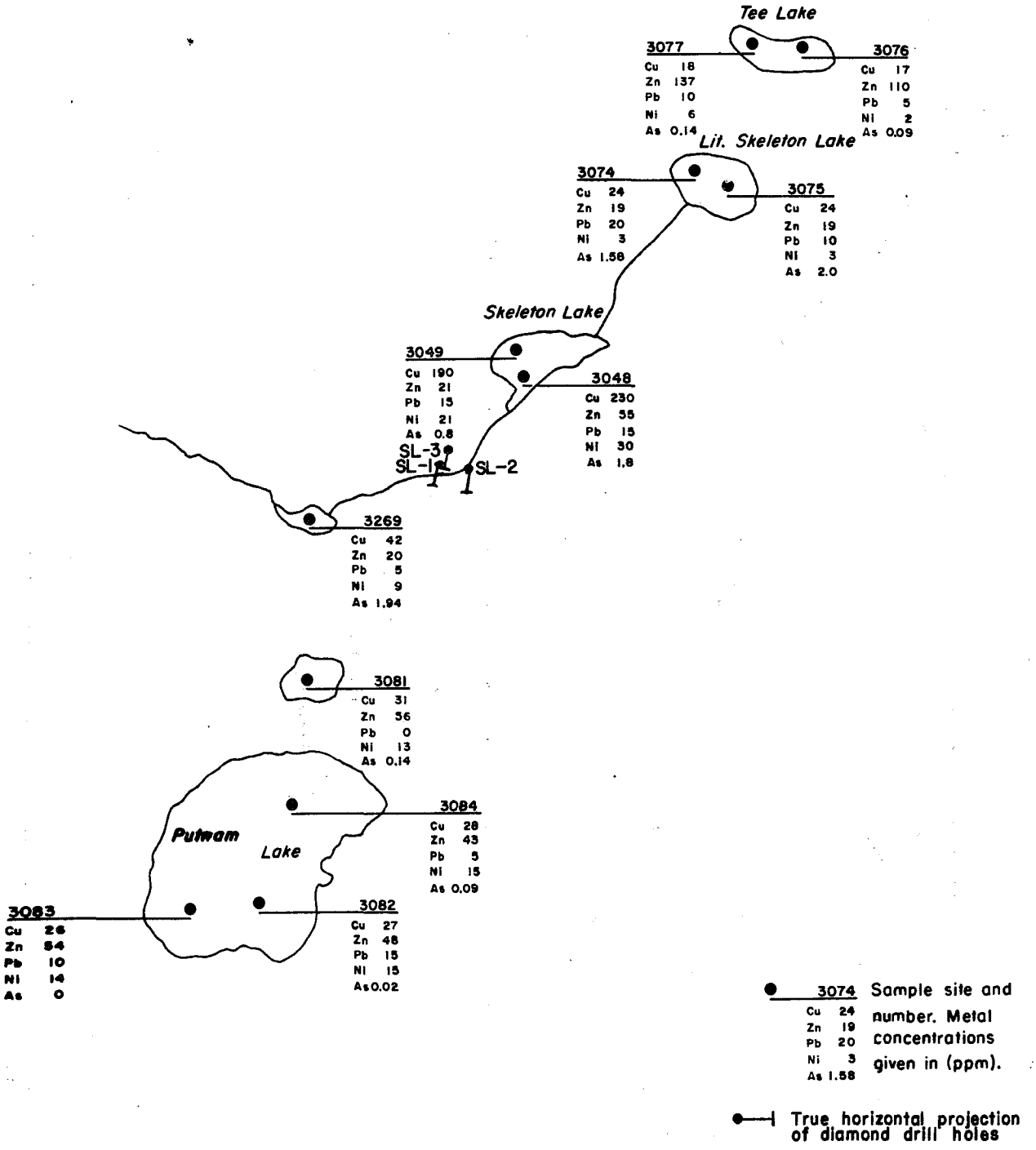


FIGURE 1: LOCATION MAP



Scale 1:24000

FIGURE 2: ORGANIC-RICH LAKE SEDIMENT SURVEY

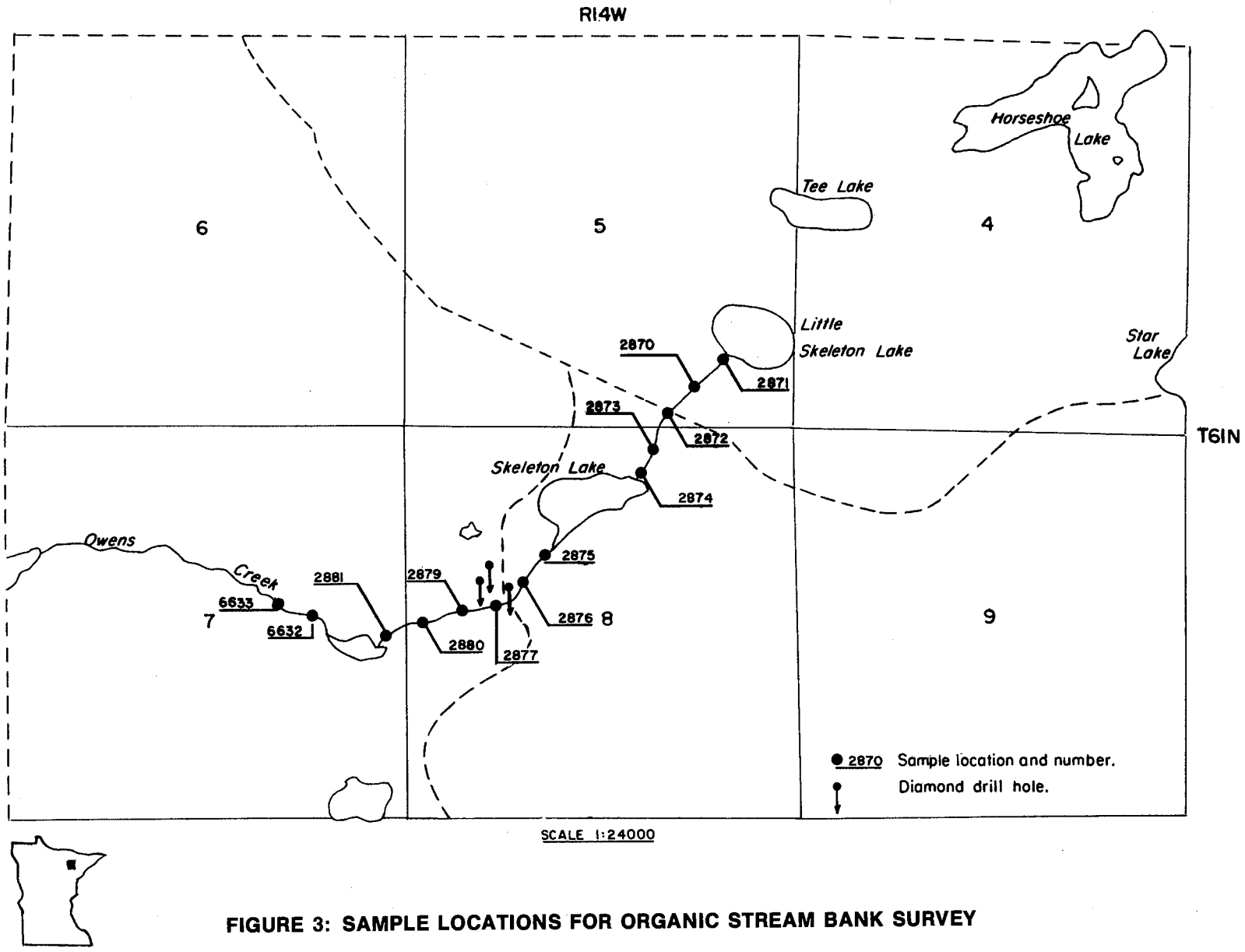


FIGURE 3: SAMPLE LOCATIONS FOR ORGANIC STREAM BANK SURVEY

REFERENCES

Meineke, D. G., Vadis, M. K., Klaysmat, A. W., 1976, Gyttja Lake Sediment Exploration Geochemical Survey c Eastern Lake Vermillion-Ely Area, St. Louis and Lake Counties, Minnesota: Minnesota Department of Nature Resources, Division of Minerals, Report 73-3-1, 53 pages.

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